

USING APPLICATIVE SOFTWARE AND SOFTWARE TOOLS FOR THE PERFORMANCE OF LEACHING AND BIO-LEACHING

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Abstract: *The refractory or low grade lead/zinc domestic ores in Republic of Macedonia are investigated by conventional separation technology or flotation separation. In the mean time, investigations are directed to the new possibilities of leaching by microorganisms – bioleaching. The paper is result of these technologies and investigations carried out for recovery of in the mentioned ores. Using Simplex EVOP and computer program Multisimplex performances are appropriate and most acceptable and excellent way for presentation of the leaching and bioleaching.*

Keywords: SOFTWARE, LEACHING, BIOLEACHING, SIMPLEX EVOP

1. INTRODUCTION

Simplex **EVOP** was proposed as an alternative to the original Box **EVOP**. The Simplex requires much less experimentation and reaches the optimum of a process much more quickly. Instead of factorial experimentation, Simplex **EVOP** uses a succession of experimental designs in the form of a regular Simplex.

The regular Simplex is the first-order design which requires the smallest number of experimental points; for n factors (n -dimensional), $(n+1)$ experimental points are required. Thus for two factors the regular Simplex design is an equilateral triangle requiring three points; for three factors the design is a regular tetrahedron requiring four points. As in other forms of **EVOP**, more than three factors can be handled but the designs cannot be shown diagrammatically. Fixing the number of measured intervals of each factor to the unit length of the Simplex side is important for all moves from the initial cycles. The regular Simplex design permits estimation of the first order effects in any number of factors. The direction of steepest ascent leading out of the Simplex is through the side or face (or hyper-plane) opposite the lowest value of response. The deletion of one old point and the introduction of one new point in this most favorable direction of movement leads to the formation of a new Simplex.

2. Advantages of Simplex EVOP

The advantages of Simplex **EVOP** are: 1. in many processes the optimum tends to move with time. Responses may indicate a moving optimum even though the true optimum does not change. It is unrealistic, and may be useless, to make process changes on the basis of out-of-date and irrelevant information; only the most recent observations should be used. 2. Simplex provides a rigorous definition of the frequency and extent of the changes to be made. Each move is from one Simplex to the adjacent Simplex. The least acceptable set of operating condition and is replaced by its mirror image in the plane (hyper-plane) of the

remaining points. 3. When the real effects are small compared with the observational errors they may be obscured and a false move may be made. As long as the change made is small compared with the changes in the basic design, no great harm will result. In any case, since any decision taken is reviewed and corrected continuously, the greater any adverse effect may be then the more rapidly will it be detected and eliminated. 4. The use of such a precise pattern of experimentation eliminates the need for statistical analysis of the data. The arithmetic involved is trivial and at no stage is it necessary to calculate the direction of steepest ascent. Although this procedure is ideal for control by means of a digital computer, plant supervisors optimizing a process with Simplex **EVOP** are under no disadvantage without a digital computer, an appropriate worksheet can be made. 5. The direction of advance depends only on the ranking of the responses and not on their scalar values. Thus Simplex **EVOP** may be used when a response can be arranged in order of preference for a combination of responses, and the least preferable combination dropped every time.

3. Disadvantages of Simplex EVOP

The disadvantages of Simplex **EVOP** are: 1. All factors must be quantitative, 2. In order to minimize wrongful elimination of points due to imprecise measurement of response, either the measurement techniques must be precise, or the Simplex points chosen must be far enough apart to outweigh the imprecision of measurement.

4. Future techniques development and recoveries of metal bearing ores

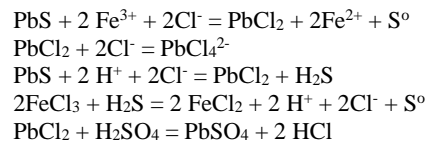
Future sustainable development requires measures to reduce the dependence on nonrenewable raw materials and the demand for primary resources. New resources for metals must be developed with the aid of novel technologies, in addition, improvement of already existing mining techniques can result in metal recovery

from sources that have not been of economic interest until today. Metal-winning processes based on the activity of microorganisms offer a possibility to obtain metals from mineral resources not accessible by conventional mining. Microbes such as bacteria and fungi convert metal compounds into their water-soluble forms and are biocatalysts of these leaching processes. Generally speaking, bioleaching is a process described as being “the dissolution of metals from their mineral sources by certain naturally occurring microorganisms” or “the use of microorganisms to transform elements so that the elements can be extracted from a material when water is filtered through it”. Worldwide reserves of high-grade ores are diminishing at an alarming rate due to the rapid increase in the demand for metals. Another major problem is environmental costs due to the high level of pollution from these techniques. Environmental standards continue to stiffen, particularly regarding toxic wastes, so costs for ensuring environmental protection will continue to rise.

Biotechnology is regarded as one of the most promising and certainly the most solution to these problems, compared to pyro metallurgy or chemical metallurgy. It holds the promise of dramatically reducing the capital costs. It also offers the opportunity to reduce environmental pollution. Biological processes are carried out under mild conditions, usually without addition of toxic chemicals. The products of biological processes end up in aqueous solution which is more amenable to containment and treatment than gaseous waste. Bacterial leaching is a revolutionary technique used to extract various metals from their ores. Traditional methods of extraction such as roasting and smelting are very energy intensive and require high concentration of elements in ores. Bacterial leaching is possible with low concentrations and requires little energy inputs. The process is environment friendly even while giving extraction yields of over 85-90%.

Lead sulfate ($PbSO_4$) as an important chemical product can be widely used in white pigment, lead storage battery and so on. [1-2] Fire metallurgy is the process which produce $PbSO_4$ from lead concentrates and electrolysis of the crude lead to produce electrolytic lead, then chemical synthesis [3-5]. Thus, there is serious pollution due to the emission of SO_2 and lead vapor as well as filled dust during processes of the lead metallurgy and electrolysis. These emissions of pollutants not only do harm to the health of operators, but also result in local atmosphere and water pollution. Under the current pressures of strict environmental regulations, seeking much efficient ways to produce $PbSO_4$ is very necessary. Many researches have done extensive work on hydrometallurgical lead production process. The ferric chloride leaching of galena has received considerable attention over the last 20 years or so [6-10]. This process is based on the rapidly of the reaction between $FeCl_3$ and PbS on the predominant formation of elemental sulphur, and on the elevated solubility of $PbCl_2$ in hot concentrated chloride media. It can be found that the methods of hydrometallurgical lead production process mainly involve lead sulfide concentrates leaching in some medium, followed by fused-salt electrolysis to produce electrolytic lead. All mentioned methods lead to the conversion of lead sulfide concentrates to lead sulfate, and to demonstrate the feasibility of realizing a

green route to prepare lead sulphate. On account of the lowest valence state of sulphur in PbS , the insoluble PbS can be transformed into soluble lead salts by strong oxidation of ferric chloride with rapid reaction and the moderate solubility of lead chloride in concentrated chloride media. During this leaching process chloride ion plays an important role, especially in saturated $NaCl$ solution system. Ferric attack of mineral:



There are several factors, affecting the leaching processes, which involve stirring speed, reaction time, and reaction temperature and lixiviant concentration. The maximum leaching rate of $PbCl_2$ from galena concentrate is 98%. The optimum leaching conditions are 250 gr/L $NaCl$, 75 gr/L $FeCl_3 \cdot 6H_2O$, 0.1 mol/L HCl , 40 min, $L/S = 20$, $pH < 2$, 1600 r/min.

5. Leaching of lead minerals

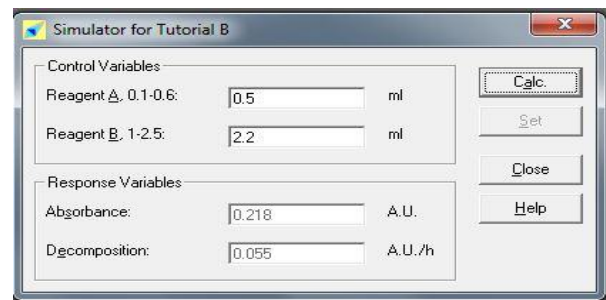


Figure 1. Graphic display

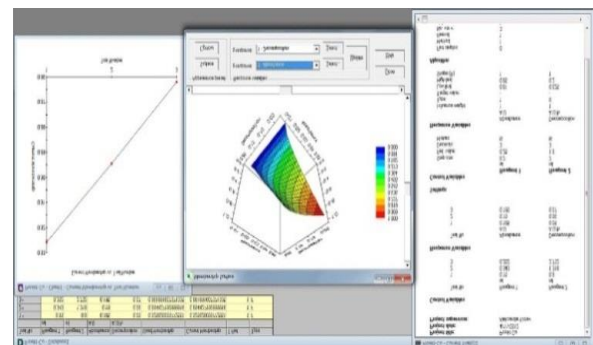


Figure 2. Graphic display

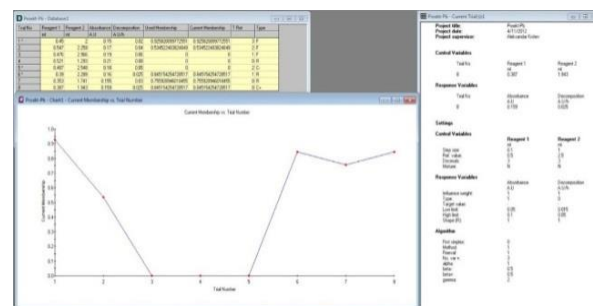


Figure 3. Graphic display

CONCLUSION

Simplex **EVOP** was proposed as an alternative to the original Box **EVOP**. The Simplex requires much less experimentation and reaches the optimum of a process much more quickly. Instead of factorial experimentation, Simplex **EVOP** uses a succession of experimental designs in the form of a regular Simplex.

Using Simplex **EVOP** and computer programme Multisimplex the tabular and especially graphic performances are most acceptable and excellent way for presentation of the leaching and microorganisms – bioleaching.

REFERENCES

[1] **Krstev B., Golomoev, B., Golomeova, M., Krstev A. (2011). “The investigations and possibility of leaching or bioleaching from nickel bearing laterite ores”, EuroBioTech Simposium, Istanbul, Turkey.**

[2] **Krstev B., Golomoev, B., Golomeova, M., Krstev A. (2011). “The choice between flotation, leaching or bioleaching from low grade copper bearing domestic ores”, EuroBioTech Simposium, Istanbul, Turkey.**

[3] **Krstev A. PhD Thessis, 2012, UGD-Stip, RM**

[4] **Krstev A., Krstev B., Golomoev, B., Golomeova, M., (October 2009). “Computer presentation in mineral processing by software computer packets”, Natural resources and technology, UGD – Shtip, FPTN N°.3, Volume 3.**